include at least one memory including computer program code. The at least one memory and the computer program code can be configured, with the at least one processor, to cause the apparatus at least to determine whether mirrored data has been fully transmitted to a user equipment. The apparatus can transmit an indication of whether the mirrored data has been fully transmitted, wherein the indication is transmitted to a node.

[0058] In the apparatus of the nineteenth embodiment, the transmitting the indication of whether the mirrored data has been fully transmitted comprises transmitting an indication of whether the mirrored data has been fully transmitted, and the node is a macro-evolved-Node-B.

[0059] According to twentieth embodiment, a computer program product can be embodied on a computer readable medium. The computer program product can be configured to control a processor to perform a method according to the seventeenth embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0060] For proper understanding of the invention, reference should be made to the accompanying drawings, wherein:

[0061] FIG. **1** illustrates one example of a U-plane that can implement one embodiment of the present invention.

[0062] FIG. **2** illustrates an example procedure in accordance with one embodiment of the present invention.

[0063] FIG. **3** illustrates a logic flow diagram of a method according to embodiments of the invention.

[0064] FIG. **4** illustrates a logic flow diagram of a method according to embodiments of the invention.

[0065] FIG. **5** illustrates a logic flow diagram of a method according to embodiments of the invention.

[0066] FIG. **6** illustrates a logic flow diagram of a method according to embodiments of the invention.

[0067] FIG. **7** illustrates a logic flow diagram of a method according to embodiments of the invention.

[0068] FIG. **8** illustrates an apparatus according to embodiments of the invention.

[0069] FIG. **9** illustrates an apparatus according to embodiments of the invention.

[0070] FIG. **10** illustrates an apparatus according to embodiments of the invention.

[0071] FIG. **11** illustrates an apparatus according to embodiments of the invention.

[0072] FIG. **12** illustrates an apparatus according to embodiments of the invention.

[0073] FIG. **13** illustrates an apparatus according to embodiments of the invention.

DETAILED DESCRIPTION

[0074] Certain embodiments of the present invention relate to dual connectivity by a user equipment.

[0075] Embodiments of the present invention are related to small-cell enhancements, such as 3GPP Release-12 small-cell enhancements, for example. One embodiment of the present invention is directed to time-division-multiplexing-based (TDM-based) dual connectivity for a user equipment (UE) with a single receiver/transmitter (RX/TX).

[0076] Providing TDM-based dual connectivity for the UE with a single RX/TX is to allow the UE to switch between receiving/transmitting with a macro-evolved-Node-B (MeNB) and a small-cell-evolved-Node-B (SeNB) using one RX/TX. By allowing the UE to switch between the MeNB and SeNB, the cost of the radio-frequency (RF) modules of the UE can be reduced. The UE can have both downlink (DL) and uplink (UL) connections with the MeNB and the SeNB in a time-division-multiplexing (TDM) manner Such dual connectivity can be applicable to different dual connectivity architecture options.

[0077] FIG. **1** illustrates one example of a U-plane that can implement one embodiment of the present invention. In the example shown in FIG. **1**, there is no direct backhaul connection (S1-MME/S1-U) from the SeNB **101** to the core network (CN). There is an Xn interface **103** between the MeNB **102** and the SeNB **101**. In other possible dual connectivity architecture options, there may be direct backhaul from the SeNB **101** to the CN. In these dual connectivity architecture options, a data split can happen in the serving gateway (S-GW) **104** instead of at the macro eNB **102**, although such splitting can still be done by the MeNB **102**. One embodiment of the present invention can be directed to dual connectivity architecture options without direct backhaul from the SeNB **101** to the CN.

[0078] Traditionally, performing hand-over generally establishes a new data path between a user equipment (UE) and a target eNB. When establishing the new data path, a "PATH SWITCH" message will generally be transmitted to change a General-Packet-Radio-Service-Tunneling-Protocol (GTP) tunnel endpoint with a serving gateway (S-GW) from a source eNB to the target eNB. Thus, downlink data can go directly to the target eNB for the relevant UE. However, in certain embodiments of the present invention, with TDM-based dual connectivity, to hide such intra Evolved Universal Terrestrial Radio Access Network (E-UTRAN) switching behavior from the CN, the downlink data may still first pass the MeNB and then go to the SeNB via the non-ideal backhaul. Hiding switching behavior from the CN allows a reducing of signaling overhead to a core network entity, which can enable large scale deployment of small cells.

[0079] One difficulty of dual connectivity relates to the handling of user-plane data while switching between the MeNB and the SeNB for TDM-based dual connectivity. For example, when transmitting downlink (DL) data, a specific TDM switching pattern can be defined by the MeNB and indicated to the UE via a radio interface. For example, in the first 20 subframes, the UE can connect to the MeNB, and, in the next 60 subframes, the UE can then connect to the SeNB with the assumption that a small cell is more adequate for high-speed downlink data transmission due to a better channel condition. The small cell can also be more appropriate for macro radio offloading purposes. During the first 20 subframes, for example, there may be 20 user data units transmitted to the UE (referred to as unit "x," unit "x+1,", . . . , unit "x+19," for example). When the UE switches to the SeNB, the unit "x+20" may not be available in the SeNB due to the delay of the non-ideal backhaul. If the backhaul latency is, for example, 25 ms (which might be even higher, such as up to 60 ms, according to Technical Report 36.839), and unit "x+20" is not available in the SeNB, when the UE switches to the SeNB and seeks to receive unit "x+20," there may be additional latency in DL transmission. When the backhaul latency varies, latency jitter will generally be unavoidable. Thus, the quality-of-service (QoS) of the EUTRAN Radio-Access-Bearer (E-RAB), which is being switched, may be violated and may thus result in poor service to end users. Due to the periodic or semi-static switching between the MeNB and the SeNB by the UE, such latency and latency jitter may happen